

Wiesław Ostrowski

University of Warsaw – Faculty of Geography and Regional Studies – Chair of Cartography
00-927 Warsaw, Krakowskie Przedmieście 30
e-mail: ostwies@uw.edu.pl

STAGES OF DEVELOPMENT OF CARTOGRAPHY AS A SCIENCE

Abstract: Three essential periods may be singled out in the development of cartography as a science:

1. From the beginning of the last century to the mid-sixties is the period of development of cartography as a distinct science.
2. The period dating from the mid-sixties till the eighties is the golden age of development of theoretical cartography with special amplification of discussions on the subject of the theoretical fundamentals of cartography. At the end of the former period and at the beginning of the latter, cartography finally distinguished itself as an independent science. In 1959, the International Cartographic Association was founded. In 1961, the International Yearbook of Cartography was published for the first time and beginning in 1969, *Polski Przegląd Kartograficzny* (the Polish Cartographic Review). A year earlier, *Komisja Kartograficzna Polskiego Towarzystwa Geograficznego* (the Cartographic Commission of the Polish Geographical Society) was established.
3. Since the mid-eighties, and even somewhat earlier, use of new IT technologies, especially interest in the map as an element of geographic information systems, has become the dominating trend in cartography.

Key words: cartography, history of science

1. THE PERIOD OF 1900–1965

During this time, such German-speaking nations as Germany, Switzerland and Austria, led the way in creating the scientific cartographic concept. After the Second World War, a significant contribution was also made by Russian and American scientists.

The German cartographer Max Eckert is regarded as the creator of the cartographic system as a science and the year 1907, in which in the article „Die Kartographie als Wissenschaft” he initiated an entire series of elaborations dedicated to defining and systemizing research on cartography, was recognized by U. Freitag (1971) as the threshold in the history of cartography.

The most complete cartographic system was presented by Eckert in the elaboration „Die Kartenwissenschaft”, published in 1921 and 1925 r., numbering in total 1450 pages, almost without illustrations. The main objective of cartography, according to Eckert, is examination of the creation process of a map as well as the analysis of its essence, structure and possibilities of use. He stresses that the science of a map – Kartenwissenschaft – is the sister and indispensable help to geography and the map itself is a philosophical stone and the eyes of geography.

As geography’s sister it shares with it research methods, which comprise:

- observation (the topographic picture is the best school of observation),
- surveying (a map is the result of countless surveys),
- use of logic, especially induction (particular objects are joined into a map picture), deduction (from general ideas to single objects) and fiction, e.g. fictitious lighting of an area in the shading method. As an example of fiction he also gives the course of an isotherm.

Beyond logic, Eckert stresses the historical method, i.e. the close relationship between geographical discoveries and the cartographic view of the world. He underlines that a historian of cartography should take into consideration cultural history, geography, the development of mathematical knowledge and the method of topographical pictures as well as reproduction methods.

Eckert’s work initiated the general cartography trend which was exemplified by, among others, preparation of subsequent cartography textbooks: E. Raisz (1938), K. A. Salishchev – a series of textbooks, first published in 1939, A. H. Robinson, first published in 1953, and in Poland, a textbook by J. Szaflarski (first published in 1953). The second trend is thematic cartography the development of which was associated with progress in thematic mapping of the globe. The Russian textbook „*Ekonomicheskaya Kartografiya*”, written by N.N. Baranskiy and published in 1940 and 1956, is regarded as the first significant publication within the framework of this trend. It was followed by

„Kartografia ekonomiczna” by L. Ratajski and B. Winid (1963) and three large works on thematic cartography from the German language area by E. Arnberger (1966), W. Witt (1967) and E. Imhof (1972).

Following the Second World War, in the fifties, new trends in cartography appeared, to be continued in the next period.

The first, the examination of perception of a map's graphic elements, initiated by A. Robinson (1952), which was reflected in his textbook. Robinson dedicated a significant chapter to graphic design of maps pursuant to the visual perception principle.

In fifties, in the Soviet Union, where association of cartography and geography was especially powerful, there already appeared a new trend, i.e. the cartographic research method. This section of cartography was foremost developed by K. A. Salishchev and his student A. M. Berlyant (1978). Worth noting is also the profusion of Russian publications on the principles of drawing and editing maps. This is related to the undoubtedly significant accomplishments of Russian atlas cartography.

The forth trend, developed by Edward Imhof, an outstanding Swiss cartographer, the first chairman of the International Cartographic Association, was the theory of map graphics. E. Imhof was particularly interested in the clarity of landscape sculpture presentations. He limited the objectives of cartography to organizing content and graphic representation of maps. According to him, the objective of cartography is to perfect the cartographic picture of the Earth. A follow-up to the Imhof theory, despite a totally different perspective, is „Semiologia grafiki” [“Semiology of graphics”] by J. Bertin (1967).

The final trend in the discussed timeframe is the idea of Erik Arnberger (1966), who assumed that cartography should serve other disciplines to express ideas on space and thus its main objective is execution of presentation methods and principles which may be applied in these disciplines. According to him, cartography is a science of form and method as opposed to geography which is the science of things.

2. THE PERIOD OF 1965–1985

A sharp increase in the number of publications on the theory of cartography was set in motion in the mid-sixties of the XXth century. This

was the result of a wide range discussion on the international forum, especially as part of the International Cartographic Association.

At the time, three concepts had the greatest significance, i.e.:

- cartology (cartographic communication),
- cognition,
- map semiotics.

2.1. THE CONCEPT OF CARTOLOGY

For the first time, the concept of cartology was presented by Lech Ratajski (1970). Cartology is defined as a system of theoretical cartography from the perspective of a cartographic information source function and at the same time as a theoretical superstructure of practical cartography.

In 1972, at a ICA conference, L. Ratajski introduced a paper „The research structure of theoretical cartography”, which was met with foremost interest. At that time, the Commission on Cartographic Communication was set up and L. Ratajski was elected its chairman. Some cartographers, among others K. H. Meine, J. Morrison, A. H. Robinson stated that along side emergence of cartology, cartography attained the status of a fully independent science. L. Ratajski based his deliberations on the cartographic communication model proposed by himself, partially modelled on the schemes by A. Kolačný (1969). This concept was developed and improved by members of the Commission on Cartographic Communication as well as L. Ratajski himself. It was met with noteworthy interest on the part of cartographers outside the Commission, among others, with criticism of Russian cartographers K. A. Salishchev and A. M. Berlyant.

K. Salishchev, supporter of the cognitive trend, foremost criticised basing the concept of cartology on the theory of mathematical information because, according to him, it brings cartography to the role of an IT discipline and subsequently constrains its objectives and tasks. Beyond general criticism of the concept of cartology, both K.A. Salishchev and A. M. Berlyant stated that in the communication process it is possible to obtain an increase of information, while in the model proposed by L. Ratajski we are dealing exclusively with its loss. This criticism, to which contributed, among others, A. H. Robinson, was recognized by L. Ratajski and the article published by him in 1977,

just prior to his death, was entitled „Losses and gains of information in cartographic communication”.

2.2. THE COGNITION CONCEPT

For the most part, the cognition concept, as opposed to the communication concept, was developing since the late sixties in the Soviet. There, cartography was very closely linked with geographic sciences and co-participated in geographic research. The field of cognition is linked to the emergence, in the fifties of the XXth century, of the cartographic research method.

The second concept being fundamental to the cognition concept was perception of a map as a specific model of reality and the process of its creation and use as cartographic modeling (Ostrowski J., 1984). In the discussed timeframe, the best known analyses of maps as reality were presented by Ch. Board (1967) and A. F. Aslanikashvili.

According to A. F. Aslanikashvili (1974), in the cartographic modelling process we come to know specific space of objects and phenomena of objective reality and its changes in time. On the other hand, K. A. Salishchev (1975) described cartography as a science “about presenting and researching distribution of objects and mutual relationships between nature and society (and their changes in time) by picture-sign models (cartographical presentations)”. According to Salishchev, the three main characteristics of maps, i.e. precise mathematical construction, use of signs and generalization, comprise the basis for the three main cognition methods: formalization, symbolization and abstraction.

As perceived by A. F. Aslanikashvili and K. A. Salishchev, the concept of cognition was criticised by numerous cartographers, including some in Poland. It was recognized that cartography may not assume the competency of geography, despite close association with it.

Undoubtedly, the most important and longest lasting accomplishment of the cognitive field is the concept of cartographic modeling which has been universally accepted and is applied, especially in work on data bases and geographic information systems, in which the conceptual model and the cartographic model are distinguished.

Among the already mentioned scientists and other creators of the cartographic modeling of special significance proved to be the model

classification proposal by G. Hake, a professor of Hanover Polytechnic, which dated back to the mid-seventies. He distinguishes the primary model, which is the result of direct observance of reality and the secondary model which is a cartographic representation, i.e. transformation of the primary model and a tertiary model which is the image of objects presented in the map (A. Czerny 1994).

2.3. THE FIELD OF MAP SEMIOTICS

M.K. Bocharov (1966), J. Bertin (1967) and A.F. Aslanikashvili (1974) are recognized as forerunners and L. Ratajski, A.A. Lutyj, U. Freitag, J. Pravda, H. Schlichtman and A. Wolodtschenko are regarded as continuators. In the scope of this scientific field, the map language defined as a system of signs alongside the principles of their construction and reading is the main research area of cartography.

According to A.A. Luty (1981), the map language is not an artificially imagined sign system but foremost, a system of an empirically formulated principle of their creation and use, formulated and developed in socio-historical practice, passed on from one generation to the next.

J. Pravda (1992) stresses that a map is not an invention of cartographers but rather a socio-historical phenomenon, a product of civilization. In a certain sense cartography resembles linguistics.

3. THE PERIOD AFTER 1985

At this time, computers totally revolutionized practical cartography and at the same time dominated the issues of research cartography. Despite a dynamic development of traditional maps, researchers' attention was, above all, focused on new computer map forms.

Three new concepts appeared in the discussed period, i.e. geoiconics, geoinformation and geovisualization. Their common characteristic is regarding cartographic representations from a broader perspective, as one of the means of obtaining or analyzing spatial data. In this regard, William Bunge's concept of metacartography (1962) may be regarded as a forerunner of these disciplines. Metacartography examines maps against the background of other communications on spatial relationships.

3.1. THE GEOICONICS CONCEPT

The geoiconics concept was introduced in the mid-eighties by A.B. Berlyant and it developed in the nineties (A. M. Berlyant, 1996). According to him, the traditional scope of interest of cartography should be enlarged by adding new kinds of geoimages.

By the idea of geoimages A. M. Berlyant understands all time-space, scale, generalized lens or process models, presented in graphic picture form. Thus broadened scope of research Berlyant named geoiconics, starting from the premise that the common characteristic of all representation is that the visual graphic picture. Geoiconics is defined as a synthetic field of knowledge engaged in the theory of geoimages, methods of their analysis, transformation and use in science and in practice.

The scope of geoiconics refers to metacartography from the perspective of Bunge but is limited because it only comprises graphic representation while Bunge also included natural language and mathematics in the interest area of metacartography.

3.2. GEOINFORMATION (GEOMATHICS)

Geoinformation is a term used from the beginning of the 90's, sometimes substituted by the term "geomathics", as proposed by Canadians. Its principal area of interest are geographic information systems GIS and because the map is a fundamental, however often underestimated, element of these systems, therefore geoinformation also comprises the so-called "new cartography".

Geoinformation is described as an area of science and technology dedicated to obtaining, storing, analyzing, processing, presentation and distribution of geographic data or information.

It is worthwhile to look at the critical to this current opinion of K.A. Salishchev (1983). „Digital information outside a map is devoid of any kind of visualization and what is more important does not detect, even using the most perfect software, the multiplicity and diversity of spatial relationships directly found by readers on a map.”

3.3. THE GEOVISUALIZATION CONCEPT (CARTOGRAPHIC VISUALIZATION)

The concept of geovisualization or cartographic visualization arose in the first half of the nineties. Its popularity may be compared to that of the communication concept of the seventh decade of the last century. There are certain analogies. As the models of Kolačný and Ratajski were fundamental to the discussion on cartographic communication so was the A. M. MacEachren model (1994), which in the shape of a cube initiated discussion on geovisualization. As in the case of the communication concept, within the International Cartographic Association, in 1993, a visualization work team was first established and in 1995, a new Visualization Commission was founded. MacEachren was its chairman. The difference is such that the geovisualization concept is the continuator of the cognitive field, in the beginning the primary rival of the communication concept but, as it was stressed, the communication concept began quickly to evolve in the direction of the cognitive concept, even though its creators did not agree to an overly broad function of cartography as a science dedicated to recognition and research of geographic reality.

In the geovisualization concept, maps are regarded as tools used to understand spatial relationships, supporting its users' thought processes. Thanks to implementation of interactive tools, three dimensional and dynamic presentations, the map's role is stressed in intellectual mobilization of its users.

D. DiBiase (1990) presented the scientific visualization model supported by a map. It comprises two map functions, i.e. communication and thought simulation. The communication function is a visual public communication and concerns maps for the wider public. Maps are executed by cartographers and the visualization process comprises synthesis and presentation. The thought stimulation function comprises cartographic expert opinions. Maps are made by experts from a given field to solve a particular problem.

MacEachren (1998) calls attention to the fact that „expectations related to visualization are based on the assumption that the process of perception and familiarization by human beings is characterized by wide range possibilities in the area of synthesis and identification of spatial arrangements, which in an excellent manner supplements the potential of computers in the area of source data processing”.

4. CONCLUSIONS

During the last century it was possible to observe three principal tendencies in cartography:

1. Transition of scientific cartography from a direct alliance with geography by becoming independent in the last quarter of the XXth century to a direct association with information science.
2. Decreasing interest in the classical issues of cartography (methodology, reduction) together with a sudden increase in the number of maps published which, among other factors, leads to deterioration of their quality.
3. In examining the long term development of cartography we may observe a trend of passing from scarcity of data needed for preparation of precise maps to excess of data which renders especially relevant the problem of generalization and organization of the search for data.

REFERENCES

- Arnberger E., 1966, *Handbuch der thematischen Kartographie*, Wien, Deuticke.
- Aslanikashvili A. F., 1974, *Metakartografiya., Osnovnye problemy*. Tbilisi, Metsnereba.
- Baranskiy N. N., 1940, *Ekonomicheskaya kartografiya*. Moskva.
- Berlyant A. M., 1978, *Kartograficheskiy metod isledovaniya*. Moskva, Izdat. Moskovskogo Univ.
- Berlyant A. M., 1996, *Geoikonika*, Moskva, Astreya.
- Bertin J., 1967, *Sémiologie graphique. Les diagrammes, les réseaux, les cartes*. La Haye-Paris 1967, Mouton et Gauthier-Villars.
- Board C., 1967, Maps as models. W: Chorley R. J., Hagget P. (ed.) *Models in geography*. London – New York, Methuen, s. 671–725.
- Bocharov M. K., 1966, *Osnovy teorii proyektirovaniya sistem kartograficheskikh znakov*. Moskva, Nedra.
- Bunge W., 1962, *Theoretical geography*. Lund Studies in Geography Ser. C., No. 1, 2 Metacartography.
- Czerny A., 1994, Rozwój koncepcji modelowania kartograficznego [Development of the concept of cartographic modelling; in Polish], *Polski Przegl. Kartogr.* T. 26, p. 185–200.
- DiBiase D. (1990), Visualization in earth sciences. *Earth & Mineral Sciences, Bulletin of the College of Earth and Mineral Sciences*, The Pennsylvania State University, 59, 2, p. 8–13.
- Eckert M., 1907, Die Kartographie als Wissenschaft. *Zeitschr. der Gesellschaft für Erdkunde zu Berlin*, p. 539–555.

- Eckert M., 1921, 1925, *Die Kartenwissenschaft. Forschungen und Grundlagen zu einer Kartographie als Wissenschaft*, Berlin u. Leipzig, W. de Gruyter.
- Freitag U., 1971, Semiotik und Kartographie. Über die Anwendung kybernetischer Disziplinen in der theoretischen Kartographie. *Kartogr. Nachr.* Jg 21, H., p. 171–182.
- Imhof E., 1972, *Thematische Kartographie*. Berlin, W. de Gruyter. Lehrbuch der Allgemeinen Geographie, Bd. 10.
- Kolačný A., 1969, Cartographic information – a fundamental concept and term in modern cartography. *Cartogr. J.* vol. 6, no. 1, p. 47–49.
- Lutyj A. A., 1981, *Jazyk karty, sushchnost', sistiema, funkcii*, Moskva.
- MacEachren A. M., 1994, Visualization in modern cartography: setting the agenda. [in:] D.R.F. Taylor and A. M. MacEachen (ed.) *Visualisation in modern cartography* London, Pergamon Press.
- MacEachren A. M., 1998, *Wizualizacja – kartografia XXI wieku* [Visualization – cartography in the XXth century; in Polish]. Systemy Informacji Przestrzennej – VIII Konferencja Naukowo – Techniczna p. 139–250, Warszawa.
- Ostrowski J., 1984, Podstawowe koncepcje teoretyczne i stanowiska metodologiczne we współczesnej kartografii [Basic theoretical concepts and methodological positions in contemporary cartography; in Polish]. *Polski Przegl. Kartogr.* T. 16, p. 161–169.
- Pravda J., 1992, W poskach predmieta i mietoda kartografii. *Vestnik Mosk-Univ.* Ser. 5, Geogr., nr 2, p. 24–28.
- Raisz E. (1938, 1939) *General Cartography*. McGraw-Hill Book Company Inc. New York.
- Ratajski L., Winid B., 1963, *Kartografia ekonomiczna* [Economic cartography; in Polish]. Warszawa, PPWK.
- Ratajski L., 1970, Kartologia [Cartology; in Polish]. *Polski Przegl. Kartogr.* T. 2, nr 3, p. 97–110.
- Ratajski L., 1977, Straty i zyski informacji w przekazie kartograficznym [Losses and profits of information in cartographic communication; in Polish]. *Polski Przegl. Kartogr.* T. 9, nr 3, p. 97–104.
- Robinson A. H., 1952, *The look of maps. An examination of cartographic design*, Madison, University of Wisconsin Press.
- Robinson A. H., 1953, *Elements of Cartography*, John Wiley & Sons, New York.
- Salishchev K. A., 1939, *Osnovy kartovedeniya*, Moskva.
- Salishchev K. A., 1975, O kartograficheskom metode poznanya (analiz nekotoryh predstavleni o kartografii). *Vestnik Mosk. Univ. Geogr.*, nr 3, p. 10–16.
- Salishchev K. A., 1983, Kartografiya na Zapade – analiz teoreticheskikh wzgladov poslednikh let, *Viestnik Mosk. Univ. Geogr.*, nr 6, p. 11–18.
- Szaflarski J., 1955, *Zarys kartografi* [An outline of cartography; in Polish], Warszawa, PPWK.
- Witt W., 1967, *Thematische Kartographie, Methoden und Probleme, Tendenzen und Aufgaben*. Hanover, Gebr. Jänecke.